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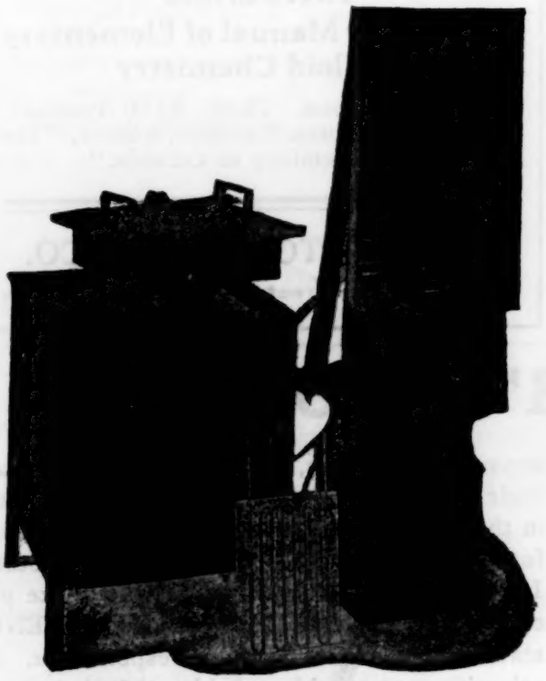

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THE SCIENCE PRESS

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SCIENCE

FRIDAY, MAY 28, 1920

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SUGGESTIONS FOR PHYSICAL INVESTIGATIONS BEARING UPON FUNDAMENTAL PROBLEMS OF PHYSIOLOGY AND MEDICINE[1]

SINCE diseased conditions imply deranged cell-processes—leading to failure of local functioning or to defective coordination between the activities of different parts of the organism—it is clear that the problem of preventing and rectifying such derangements in man (the problem of medicine) resolves itself ultimately into the means by which cell-processes can be restored to the normal after disturbance. A scientific (as distinguished from an empirical) knowledge of how to restore normal conditions must be based on an exact knowledge of the conditions determining normal protoplasmic activity, and this knowledge presupposes a fuller insight into the fundamental physico-chemical constitution of protoplasm, since it is only through an understanding of the properties of the essential living substance that we can hope to understand how the living system acts under different conditions.

The fundamental questions are thus: what kind of a system, in the physico-chemical sense, is living protoplasm? and what are the conditions of equilibrium, *i. e.*, of normal self-maintenance, of such a system?

As a physico-chemical system protoplasm is peculiar in various respects, of which perhaps the chief are:

1. The self-maintenance of the system through its own continued chemical activity; *i. e.*, the preservation of the normal equilibrium—or continued life—depends upon the active continuance of the chemical processes

[1] Contribution to the discussion at the Conference on Biophysics held by the National Research Council, Division of Medical Sciences, at Washington, February 21, 1920.

of the protoplasmic system, *i. e.*, upon metabolism.

2. This metabolism involves a continual construction of complex specific compounds—typically compounds of high chemical potential—to replace those disintegrated (as a result or oxidation or otherwise) in the energy-yielding or otherwise destructive processes of protoplasm.

3. The rate and in part the character of both the energy-yielding and the constructive metabolism are readily influenced by changes in the external conditions: *i. e.*, protoplasm is a characteristically *irritable* system—one of unstable equilibrium.

4. The ratio of constructive to destructive metabolism may vary widely under different conditions; excess of construction over destruction involves growth; equality of the two is equilibrium, implying a stationary condition as regards size and properties; while excess of destruction leads to regression, as in starvation. Obviously regression, if sufficient, must impair functional capacity and eventually lead to death.

5. The power of *growth* is thus inherent or potential in all forms of protoplasm during life. Those pathological problems which relate to excessive or otherwise abnormal growth or proliferation (*e. g.*, the case of tumors) thus require for their scientific solution a knowledge of the physico-chemical conditions of normal growth.

It is evident, since growth is an inherent property of the living system—*i. e.*, since the continuance of the living state depends on this power of specific construction—that the problems just cited relate themselves directly to the general group of problems having reference to the essential physico-chemical constitution of protoplasm. The protoplasmic system is primarily a growing or synthesizing system, at the same time as it is a system which continually yields material and energy to the surroundings through the chemical breakdown of certain components. The chief aim of general physiology is to understand the type of physical and chemical constitution that makes possible chemical activities of this general kind.

Experiment shows that destroying the structure of protoplasm, by mechanical or other means, destroys most (though not all) of its chemical activity (including the latter's susceptibility to electrical influence), and in particular its power of specific synthesis or growth. Hence this power must depend on the special structure of the system. The chemical reactions constituting metabolism take place within a field or substratum having a special type of structure (*i. e.*, arrangement of phases); and the nature and rate of the metabolic reactions are controlled by the structural conditions present. These structural conditions are themselves produced by the growth of the system itself, or of another system having similar properties.

It must be recognized that the problem of the fundamental constitution of living protoplasm underlies all of the problems of biology—including ultimately those of medicine, as a branch of applied biology. It is therefore all-important from the practical as well as from the purely scientific standpoint that this problem should be the subject of continual and active study and investigation.

Physical Processes of Fundamental Importance in Protoplasmic Activities.—The research of the past fifteen years has made especially clear the importance of surface-processes in the activity of living matter. The behavior and properties of colloids (the substances composing most of the solid material of protoplasm) are largely determined by surface conditions (adsorption, variations of phase-boundary potentials, interfacial tensions). Electrical stimulation depends upon sudden changes in the electrical polarization of the semi-permeable surfaces of the irritable cell. Protoplasmic movement (muscular contraction, etc.) is almost certainly due in most cases to the changing surface-tension of the structural elements composing the contractile fibrils. Growth processes show various significant resemblances to structure-forming processes occurring under the influence of local electrolysis at metallic surfaces in contact

with electrolyte solutions (formation of precipitation-tubules of zinc or iron ferricyanide, rust-patterns, etc.). Transmission-effects in protoplasmic systems (*i. e.*, in nerve, etc.) may be closely paralleled by processes of chemical transmission or distance-action in film-covered metallic systems, like passive iron in nitric acid or mercury in hydrogen peroxide. Many cell-processes are associated with changes in the osmotic properties or permeability of the protoplasmic surface-films or plasma-membranes. The high development of surface layers or membranes is in fact a long-recognized structural peculiarity of living matter. The prevalence of the cellular type of organization is in itself evidence of the fundamental importance of this condition.

These general facts indicate strongly that for the purpose of gaining further insight into the physico-chemical constitution of living matter a more thorough and detailed study (1) of the general properties of surfaces (their structure, tension, electrical properties, etc.), (2) of the layers of material formed at surfaces (surface-films, etc.), and (3) of phenomena dependent on surface conditions (adsorption, catalytic effects, flocking and peptization of colloids, etc.), is all-essential. Probably the purely physical or chemical investigation of these problems will best be undertaken by students trained in the methods of physics and physical chemistry. Data or principles so obtained can then be applied to biological or medical problems by those specially qualified to deal with such problems.

There is much evidence that living protoplasm is essentially *emulsion-like* in its fundamental physical constitution; and it is known that the properties of emulsions are largely determined by the presence of interfacial films and by the electrical and other conditions resident at the phase-boundaries. The general physical and chemical conditions affecting the stability and properties of emulsion-systems are thus in large part identical with those affecting the stability and properties of living protoplasm. As is well known, emulsions are mixtures of two (or more) mutually insoluble liquids, of which one is in a state of fine division and dispersed throughout the other; for stability a third substance (*e. g.*, soap), forming a surface-film between the two phases, is usually required. Recent work has shown that the properties of oil-water emulsions may be made to vary in a remarkable manner by varying the salt-content of the system, and that these changes depend upon the solubilities of the soaps formed and upon their surface-activity. Many surprisingly close parallels between the effects of different combinations of salts on emulsion-systems and on living protoplasmic systems have been demonstrated. It is well known that the presence of inorganic salts in definite proportions is essential to the normal activity of most living cells. Such results, therefore, indicate the importance of initiating and extending researches which will have as their object the determination of the relation between the soluble substances (both electrolytes and non-electrolytes) present in emulsion-systems and the general physical properties and behavior of such systems. Light may thus be thrown upon the general properties of protoplasm (mechanical properties, structure, permeability, electrical properties), in so far as these properties are determined by the emulsion-like constitution of the system.

This emulsion-structure, however, furnishes only the field or substratum in which the essential chemical reactions (or metabolism) of the living protoplasm proceed. The special nature of these chemical processes determines the special properties and behavior of the protoplasmic system. Hence the relation of the film-pervaded or emulsion-like structure of protoplasm to the special type of chemical activity exhibited by the living system should be thoroughly studied and investigated. There are many indications that the extraordinary chemical capabilities of living matter are dependent upon the extent of its surface development: *i. e.*, that the influence of protoplasm in inducing chemical reactions not found elsewhere is essentially the result of the special predominance of surface influences of a peculiar kind. And since the sensitivity of living matter to the electric current is one of

its most characteristic peculiarities, it appears probable that the chemical reactions in protoplasm are largely controlled by variations in the electrical potential-differences present at the various protoplasmic phase-boundaries (the surfaces of membranes, fibrils, etc.). At present our knowledge of chemical processes occurring under electrical control is almost entirely confined to those observed at the surfaces of metallic electrodes in contact with electrolyte solutions. These are the well-known phenomena of electrolysis. Knowledge of such processes should be extended to include the case of electrolysis at other interfaces, *e. g.*, between an oil phase and a water phase. The technical difficulty here appears to be largely one of conducting the current through the non-aqueous phase. But since many of the chemical reactions in protoplasm are demonstrably under electrical control, it is clear that metallic surfaces (*i. e.*, metallic electrodes) are not necessary to the production of chemical effects by the electric current. Apparently in the living cell surfaces of other composition play the same part. There seems to be here a field of investigation which should throw much light upon the conditions of the chemical processes in protoplasm. The phenomena of polar stimulation, polar disintegration and similar effects in physiology are an obvious counterpart of the polar differences between the chemical effects of anode and cathode in electrolysis. Undoubtedly the same fundamental basis exists for the polarity in the chemical effects of the electric current in the living and in the non-living systems. The effects produced by passing currents through appropriately constituted emulsion-systems containing readily alterable (*e. g.*, oxidizable) chemical compounds might well be investigated to advantage in relation to this problem. Closely related also would be a study of the surface-films formed at the interfaces between pairs of fluids, or between fluids and solids, and the effects of electrical and other conditions upon such films.

Progress in these and related departments of physical research would undoubtedly be of great service to general physiology at the present stage of its development. Many fundamental physiological processes—growth, cell-division, muscular contraction, response to stimulation, transmission of stimuli, chemical control of metabolism, etc.—must remain imperfectly intelligible without the extension of exact knowledge in these fields. The possibilities of the control of vital processes, including the control of diseased conditions, would certainly be greatly enlarged with a more fully developed general physiology. The problems suggested above have many aspects of purely physical and chemical interest, apart from their physiological bearing; and it is to be hoped that properly equipped investigators may be found to engage in their study.

Ralph S. Lillie

Clark University,
Worcester, Mass.

THE LONGNECK SAUROPOD BAROSAURUS[1]

In 1889 Professor O. C. Marsh secured from the shales overlying the sandstones following the marine Jura, near Piedmont on the eastern "Rim" of the Black Hills, various fragmentary caudals of a huge sauropod. In these he recognized a new type which he called *Barosaurus lentus*. He had been kindly advised of the occurrence, and was accompanied by the noted collector J. B. Hatcher, but attempted no adequate excavation.

Nine years later, in the midwinter of 1898, after a friendly letter from Professor Marsh, I visited him at New Haven and discussed the subject of field work in the west for the succeeding summer. Knowing that after Hatcher left Yale several years earlier the field work on the Dinosauria had suffered, I

[1] 1890. O. C. Marsh, *Barosaurus lentus* gen. et spec. nov. in "Description of New Dinosaurian Reptiles," *Amer. Jour. Sci.*, January, page 86, Figs. 1 and 2. 1919. R. S. Lull, "The Sauropod *Dinosaur Barosaurus* Marsh—Redescription of the Type Specimens in the Peabody Museum, Yale University," *Memoirs of the Connecticut Academy of Arts and Sciences*, Vol. VI., pp. 1–42, with figures in text and 7 plates.

wished to begin with that group, through general interest in the reptilia. But two other subjects also claimed attention—the fossil cycads and the great turtles of the Pierre. The cycads I had wished to hunt for when in the Black Hills; and the studies begun with the discovery of the huge *Archelon,* the most remarkable of sea-turtles, urgently needed continuation. However, as to which subjects should take the precedence Professor Marsh was close to obdurate—they should be within my interest. This I recall pleasantly; for mayhap vertebrate paleontologists are a bit prone to use the word "direct" with a sort of obviousness. It may occur on labels in letters of inconsistent size, or in descriptions. But this was not Marsh, as I can testify. He advised with others, however meager their experience, was anxious for their best word, and valued the mental sanction of those he worked with. Only may this be called direction in the sense of singling out the roadway along which to make history. And in this sense, when it came to the fossil-bearing horizons of the west, was there ever another such a man as Marsh? He said, as I left for the field—"The Black Hills are a diamond edition of geology, prepared especially for the use of geologists by the Almighty."

Accordingly, in the latter part of August, 1898, I began the excavation for *Barosaurus.* This I carried out alone. The quarry was extended to a sixty-foot front, and ran some thirty feet back to a depth of ten feet. The first material secured was fragmentary and seemed to run out following a group of good caudals. Then a well-conserved portion of a proximal caudal, probably No. 1 was uncovered; but on interrupting the work for further prospecting for the cycads and dinosaurs, the centrum was found cut off by an ugly shear. Nearly decided that the lead had come to an end, on working down to a two-foot lower level, various dorsals, a few chevrons, rib fragments, and a sternal plate, promised a rather featureless aggregate. Much checking with extreme lightness of the vertebral structure made it necessary to hold all parts in place as uncovered. This slow task lasted into the late fall, when cold and dust storms made excavation difficult.

Finally, in the course of working forward, there came four cervicals running up to one with a centrum three feet long, as once recognized as unparalleled in the Dinosauria; though much more robust types as long are now known. It then appeared that the main group of skeletal elements, although much displaced, or only partly conserved, represented a single individual; but unluckily the long cervicals led out to a gullied surface. All possibility of further recovery was at an end. Yet the result seemed a real triumph, over which Marsh was quite elated; he held in hand novel Dinosaurian material new from the field.

And now, after twenty-two years Professor Lull, of Yale, has described this unique type in the excellent memoir of the Connecticut Academy cited. Since its discovery, Riggs has named a very striking sauropodan from Colorado, *Brachiosaurus altithorax,* from the huge humeri exceeding in size the femora; while the related *Gigantosaurus* was later found in the Tendaguru of East Africa. These are quite the largest of Dinosaurs. Also, *Diplodocus* has been redintegrated with signal success at the Carnegie Museum of Pittsburgh.

The *Barosaurus* has, as Marsh thought, some resemblance to *Diplodocus.* In that genus length of neck, dorsal shortness, and great caudal length, are correlated with lightness of vertebral structure. In *Barosaurus* the vertebral type is very similar, with shortness of the dorsum. But Professor Lull finds a strong presumption that the humerus exceeded the femur in length, as in the American and African high-shouldered sauropods; while the length of neck is extreme, with a lesser caudal length.

Fortunately *Barosaurus* (type) includes in good condition at least the proximal half of the pubis. The pubis is one of the most variable and characteristic skeletal elements throughout the Dinosauria, and Lull finds a primary resemblance to *Diplodocus* which may

possibly be contested. It is true that there is in both forms a long shaft constriction. But in *Barosaurus* the ischiatic contact is not short, but long or rather deep, and concave as in *Apatosaurus*. The type is in this feature composite. In fact if a form uniting features of the greater sauropods, including the *Camarasaurus*, were sought, so far as public features go, *Barosaurus* might well be named.

Regarding a proximal femur fragment which is found to far exceed the proportions in *Diplodocus*, I may say that in no case is the femoral size absolutely determinate as large. The group of fragments from a Piedmont village "rock pile" or "fossil heap" purported to come from the *Barosaurus* quarry site. But only seven miles northerly there was an exposure of a fast disappearing Dinosaur bone bed several acres in extent. Being all outside the frost line, the material present in variety was much checked and broken. So fragments of limb bones could have been taken from this point to the "rock pile" at Piedmont, mainly, if not exclusively from the real *Barosaurus* outcrop. Or again, if the record fails, it is to be recalled that a second (though actually smaller) dinosaurian was recognized by Marsh in the material from the outer edge of the quarry, as confirmed by Lull. The point is that if a second form could so occur on the erosion or quarry front, then there might also be a third. A waterway, stream, or trend of some kind is indicated.

It is worthy of addition that in the *Barosaurus* quarry well inside the frost line, there were various fragments of charred or carbonized wood passing into silicified structure. Such material from the Morrison has not been studied. Also, various pebbles of a singular smoothness were noted at only one point close to the main group of dorsals. As the specimen was incomplete the reasonable explanation that these were stomach stones, or as later called, dinosaurian gastroliths, did not then occur to me, their true character being first recognized in examples from the Big Horn mountains.

Obviously *Barosaurus lentus* is a remarkable dinosaur from several points of view. It comes from far to the north and east of the Wyoming localities, and shows the great extent of the Como beds, as Marsh called them. The parallel with the African types adds great interest to *Barosaurus*. As a specimen it promised little of determinate value after two months quarry work, and then suddenly turned out to be, "except for the lack of limbs, one of the finest of all Yale specimens." The type remains somewhat isolated because collecting along the inner edge of the Black Hills "Rim," though never hopeless, is always much limited by the long talus slopes hiding the Morrison. This formation encloses the Hills and the Bear Lodge horseshoe-like, with the open heel on the southeast from north of Buffalo Gap to near Minnekahta. On the west side of the Hills the maximum thickness of 200 feet is reached. There, as further west in the Big Horn Rim and in the Freeze Outs, is found the association of the smaller silicified cycads with the sauropod Dinosaurs. And both in the Morrison, and in the overlying Lakota, from the lowermost strata of which comes the fine cycadeoid *Nilssonia nigracollensis*, a long contemporary cycadophytan and dicotyl record of the Comanchean is yet to be brought to light. Reconnaissance in this important field is but begun.

G. R. Wieland

Yale University

LOUIS VALENTINE PIRSSON

Professor of physical geology in the Sheffield Scientific School of Yale University for twenty-one years, after rapid promotion from the position of instructor in geology and lithology, to which he was appointed in 1892; Professor Pirsson also occupied a position of commanding importance in the administrative work of the Scientific School, as member of the governing board, and as assistant to the director, Professor Chittenden, in matters of discipline and general policy. An assistant in analytical chemistry for six years after graduation from the Scientific School, he

taught for a year in the Brooklyn Polytechnic Institute, and then became interested in geology and petrography as an assistant field-worker for the U. S. Geological Survey in the Yellowstone National Park; carrying on studies in mineralogy and petrography in Professor Penfield's laboratory, and afterwards with Rosenbusch in Heidelberg and with Lacroix in Paris. For nine years he was an assistant and special expert on the U. S. Geological Survey, and since 1904 a geologist in this service.

Although a successful teacher of physical geology to undergraduate students, his special interests were in petrology, which he taught to graduate students, and to which he devoted more than half of his time and most of his thought, as may be seen in his publications. His research work was almost wholly petrological. Beginning with his observations of igneous rocks in the Yellowstone Park, he studied independently, and in conjunction with W. H. Weed, the districts of Castle Mountain, Judith river basin, the Highwood and Little Belt Mountains, and other localities in Montana; and he contributed numerous papers on the petrography of New Hampshire in the region of Squam Lake. He was joint author with Cross, Iddings and Washington of a Quantitative System of Classification of Igneous Rocks.

Professor Pirsson was especially successful in the preparation of text-books. His elementary work on "Rocks and Rock Minerals," written for a course of instruction without the use of microscopical methods of diagnosis, has been in general use for the past twelve years. Later he prepared a text-book for his undergraduate class in physical geology which is highly esteemed and widely used; the historical part of the volume having been written by Professor Schuchert. A more elementary form of the work was under consideration shortly before his death. He had begun an elementary petrography which was left unfinished, greatly to the regret of teachers of the subject.

In addition to being a careful observer and a painstaking and industrious student, he was methodical and systematic in his work, and thorough in his treatment of a subject. Moreover, he recognized the importance of emphasizing fundamental principles. He was an associate editor of the *American Journal of Science* from 1897 to the time of his death. There was a definiteness in his conceptions and in his statements that rendered his teaching effective and commanded the respect of his students. Confident in his own judgment, and tenacious of his convictions, he was at the same time considerate of the opinions of others and conscientious in his dealings with them.

By temperament cautious, he was reserved in his intercourse with strangers, but genial and outspoken in the company of friends. A man of great patience and of simple tastes, he enjoyed a quiet life in the study of nature, being especially fond of watching birds and wild animals, and of the sport of fishing; and having a photographic memory for details and a fine sense of humor, he was an entertaining story-teller, and occasionally contributed his experiences to *Forest and Stream*.

In recognition of his scientific attainments he was made a member of the National Academy of Sciences, American Philosophical Society, Geological Society of America, of which he was vice-president in 1915; fellow of the American Academy of Arts and Sciences, Connecticut Academy of Arts and Sciences, Washington Academy of Sciences, Geological Society of Washington, and an honorary member of the Geological Society of Stockholm.

Louis Pirsson was born in New York City, November 3, 1860, was prepared for college at a private school, graduated from the Sheffield Scientific School of Yale with the degree of Ph.B., in 1882, and was given the degree of A.M. by Yale University in 1902. He studied petrography in Heidelberg and Paris in 1892. In 1902 he married Eliza Trumbull Brush, of New Haven, daughter of Professor George J. Brush. His death, after prolonged illness from rheumatism, is a severe blow to the science of petrology, of which he was the foremost teacher in this country, and a sad

bereavement to his colleagues with whom he maintained the friendliest relations.

J. P. Iddings

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE FOURTH ANNUAL MEETING OF THE PACIFIC DIVISION

The fourth annual meeting of the Pacific Division, of the American Association for the Advancement of Science will be held at Seattle in quarters provided by the University of Washington on June 17–19, 1920.

The 1919 meeting held at Pasadena was a pronounced success, exceeding in point of interest and attendance any previous meeting, and fully justifying the wisdom of the national council in providing for a geographic division of the American Association to accommodate the large and active membership residing west of the Rocky Mountains.

Notwithstanding the long distance between centers of population on the Pacific coast, or perhaps rather on account of them, the executive committee has pursued the plan of holding the annual meetings alternately in different and widely separated sections of the Pacific Coast area, believing that although the largest attendance is not to be realized in this way, it best subserves the purposes of the organization in stimulating an active interest in science throughout the district and in promoting that cooperation among scientific men which must be effective in meeting local problems.

The Exploration of the North Pacific Ocean was discussed at the Pasadena meeting in a symposium which outlined in a general way the urgent need of launching this project and the great practical benefits which must accrue. Some of the many scientific problems involved in the undertaking were also presented by prominent specialists who took part in the symposium. Credit should be given to Dr. William E. Ritter, of the Scripps Institution for Biological Research, who fathered this symposium and whose vision of the great economic and scientific advantages to be gained by international cooperation in this enterprise now seems in process of realization. At least the attention of the National Research Council is directed to the matter and a committee has been appointed which will report on ways and means. This committee has already held one meeting and will meet again in Honolulu in August of this year. This great enterprise is felt to be of peculiar significance to the Pacific coast, and a second symposium on "The Animal and Plant Resources of the North Pacific Ocean" will be presented at the Seattle meeting. Naturally the fisheries, as constituting the most considerable present resource of the ocean, will receive major consideration in this symposium, and Seattle as the center of the fishery industry, seems the logical place in which to develop this phase of the subject. Quoting from the preliminary announcement of the Seattle meeting:

> The thorough presentation of the fisheries problems as they confront the industry to-day should prove to be a direct contribution to a better understanding of what this great project means. International in its scope, involving the vital interests of all peoples bordering on the Pacific, it perhaps offers the only solution that will meet the needs of the teeming populations of the Orient, and thus remove by peaceful, scientific means the menace of future conflict. The resources of the Pacific—by what shall they be gauged? A comparatively unknown field awaits our conquest.

Following is the arrangement of the symposium which will be held on Thursday afternoon June 17:

THE ANIMAL AND PLANT RESOURCES OF THE NORTH PACIFIC OCEAN

Marine biology in relation to the North Pacific fisheries: Dr. C. McLean Fraser, director, Biological Station, Nanaimo, British Columbia.

Relation of scientific investigations to the fisheries: Mr. W. F. Thompson, fisheries investigator, California Fish and Game Commission.

Present condition and needs of the Alaska salmon fisheries: Dr. Hugh M. Smith, commissioner, Bureau of Fisheries, Washington, D. C.

Future of the Alaska fisheries: PROFESSOR JOHN N. COBB, director, College of Fisheries, University of Washington, Seattle, Wash.

The methods of the salmon fisheries and salmon culture in Alaska should be completely changed. How can this be done? DR. BARTON WARREN EVERMANN, director, California Academy of Sciences, San Francisco.

Ocean pasturage and ocean fisheries: MR. W. E. ALLEN, Scripps Institution of California, La Jolla.

Thursday evening, June 17, will be devoted to the address of the retiring President Dr. John C. Merrian who will speak on "The research spirit in everyday affairs of the average man." President Henry Suzzallo, of the University of Washington, will welcome the delegates and response will be made by the chairman of the executive committee Dr. Barton Warren Evermann. Following the address of the evening a public reception will be held.

Friday afternoon, June 18, a public address will be given by Professor R. W. Brock, of the University of British Columbia, speaking on "The last crusade under Allenby." Professor Brock will speak of his personal experiences with General Allenby and will relate something of the contributions of science to the winning of the campaign in Palestine.

Following are the affiliated societies which will hold meetings at Seattle under the auspices of the Pacific Division:

AMERICAN PHYSICAL SOCIETY

J. S. Ames, *President,* Johns Hopkins University.

Dr. C. Miller, *Secretary,* Case Scientific School.

E. P. Lewis, *Local Secretary for the Pacific Coast,* University of California.

AMERICAN PHYTOPATHOLOGICAL SOCIETY, PACIFIC DIVISION

F. D. Heald, *President,* Agricultural Experiment Station, Pullman, Wash.

W. T. Horne, *Secretary-treasurer,* of the University of California.

ASTRONOMICAL SOCIETY OF THE PACIFIC

J. H. Moore, *President,* Lick Observatory.

D. S. Richardson, *Secretary-Treasurer,* 2541 Hilgard Avenue, Berkeley.

CALIFORNIA SECTION AMERICAN CHEMICAL SOCIETY

Robert E. Swain, *President,* Palo Alto.

Bryant S. Drake, *Secretary-Treasurer,* 5830 Colby Street, Oakland.

COOPER ORNITHOLOGICAL CLUB

Northern Division

Curtis Wright, Jr., *President,* Oakland.

Mrs. James T. Allen, *Secretary,* Berkeley.

Southern Division

Loye Holmes Miller, *President,* State Normal School, Los Angeles.

L. E. Wyman, *Secretary,* 3927 Wisconsin Street, Los Angeles.

CORDILLERAN SECTION, GEOLOGICAL SOCIETY OF AMERICA

George D. Lauterbach, *President,* University of California.

A. F. Rogers, *Secretary,* Stanford University.

THE ECOLOGICAL SOCIETY OF AMERICA

Barrington Moore, *President,* American Museum of Natural History.

A. O. Weese, *Secretary-Treasurer,* University of Mexico.

NORTHERN INTERMOUNTAIN SECTION, AMERICAN CHEMICAL SOCIETY

Charles H. Hunt, *Secretary,* State College of Washington.

PACIFIC COAST BRANCH, PALEONTOLOGICAL SOCIETY

John C. Merriam, *President,* University of California.

Chester Stock, *Secretary-Treasurer,* University of California.

PACIFIC FISHERIES SOCIETY

C. McLean Fraser, *President,* Biological Station, Nanaimo, British Columbia.

S. H. Dado, *Secretary,* California Fish and Game Commission, San Francisco.

PACIFIC SLOPE BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

E. M. Ehrhorn, *Chairman,* Honolulu, H. T.

E. O. Essig, *Secretary,* Berkeley.

PUGET SOUND SECTION, AMERICAN CHEMICAL SOCIETY

A. L. Knisely, *President,* C. A. Newhall Co., Seattle, Wash.

R. T. Elliott, *Secretary,* U. S. Bureau of Chemistry, Seattle, Wash.

SAN FRANCISCO SECTION, AMERICAN MATHEMATICAL SOCIETY

H. F. Blichfeldt, *Chairman,* Stanford University.

B. A. Bernstein, *Secretary,* University of California.

WESTERN SOCIETY OF NATURALISTS

J. R. Slonaker, *President,* Stanford University.

Tracy I. Storer, *Secretary-Treasurer,* Museum of Vertebrate Zoology, Berkeley.

MEETING OF PACIFIC COAST ECONOMISTS

A meeting of Pacific Coast economists will be held and a program arranged for Thursday and Friday afternoons, June 17 and 18. An effort will be made to organize a Pacific Coast Division of the American Economic Society.

SCIENTIFIC EVENTS

THE MATHEMATICAL INSTITUTE OF THE UNIVERSITY OF STRASBOURG

Helped by the favorable exchange level, a number of students are going to study in French universities. It is important to bring to their attention that, since November, 1919, the University of Strasbourg, completely reorganized, is working in full order. Its teaching staff is more than equal in number to what it was under German rule, and its equipment, already excellent in many respects, has been greatly improved where it was deficient.

For mathematical study, students will be offered in Strasbourg the usual standard courses on analysis, mechanics, astronomy, etc., the program of which is permanent and requires the students' time for two or three years. Research courses have been arranged for candidates for the "Doctorat de l'Université de Strasbourg," and of scholars generally. French diplomas are required for registration with a view to the doctorate, but can be dispensed with on presentation of equivalent foreign diplomas, with a statement of the student's ability by one of his former professors.

The program of research courses during the academic year 1920–21 is as follows:

First Semester (November 1, 1920–February 28, 1921)

Mathematical Physics: Mr. Bauer: Quantum Theory; Atomic Structure: 3 lectures a week.

Higher Analysis: Mr. Fréchets Theory of Chance: 2 weekly lectures; Integral Equations: 1 weekly lecture.

Second Semester (March 1, 1921–June 30, 1921)

Mathematical Physics: Mr. Bauer: Statistical Applications of Quantum Theory: 3 weekly lectures.

Higher Analysis: Mr. Fréchet: Applications of the Theory of Chance: 1 weekly lecture.—Functions of Lines: 2 weekly lectures.

Hydrodynamics: Mr. Villat: Researches on the Motion of a Solid in a Viscous Fluid: 2 weekly lectures.

Differential Geometry: Mr. Pérès: Transformations of Surfaces Applicable on Quadrics: 2 weekly lectures.

Theory of Functions: Mr. Valiron: Dirichlet's Series and Facultative Series: 2 weekly lectures.

For further information apply (in French or English) to M. le Directeur de l'Institut de Mathématiques de Strasbourg, Bas-Rhin, France.

Details concerning lodgings, etc., will be supplied by the Comité de Patronage des étudiants étrangers Université, Strasbourg, Bas-Rhin, France.

Students who wish to improve their knowledge of the French language during the vacation may apply for the circular on "Summer Courses," organized by the "Faculté des Lettres de Strasbourg."

THE FOREST PRODUCTS LABORATORY DECENNIAL CELEBRATION

The Forest Products Laboratory was organized by the U. S. Forest Service in 1909 and formally opened in June, 1910. It is conducted in cooperation with the University of Wisconsin.

During the ten years of its existence the efforts of the laboratory have been devoted to the development of improved methods and processes for the better utilization of forest products of all kinds, and to the direct assistance of the industries concerned. Among the major lines of endeavor are the following:

Pulp and paper,
Hardwood and softwood distillation,
Preservation of wood,
Decay and decay prevention,
Mechanical properties of wood,
Glues for wood,
Kiln drying and air seasoning,
Grading structural timbers,
Grading lumber,
Laminated construction,
Chemistry of wood,
Boxing, crating, packing,
Needle and leaf oils,
Ethyl alcohol from wood waste,
Wood finishes,
Aircraft parts,
Veneers and plywood,
Steam bending,
Identification of wood,
Microscopy of wood.

During the war direct assistance was rendered the War and Navy Departments and various other branches of the government in the solution of many important problems, particularly in connection with aircraft, gun-stocks, artillery wheels, escort wagons and the boxing and crating of arms and stores for overseas shipment. It was necessary, throughout this period, to abandon all work on the regular peacetime program.

A good many men acquainted with the work of the laboratory have expressed the thought that the laboratory and the service rendered by it should receive some mark of recognition or appreciation from the industries which it serves. In response to this thought, the decennial celebration has been planned, and a general committee organized to carry out the detailed arrangements.

The present plans call for a two-day program, including addresses by men prominent in science, industry and commerce; inspection of the laboratory; a banquet; and various other forms of instruction and entertainment. It is proposed to make a permanent record of the decennial in the form of a souvenir publication to contain all of the addresses and other relevant matter, including the names of those who can permit a permanent record of their cooperative contributions to be made.

ENGINEERING INVESTIGATIONS OF THE U. S. GEOLOGICAL SURVEY

A CORRESPONDENT writes:

In these days of economizing in government appropriations it is refreshing to note some of the remarks on the floor of the House by Representative Good, of Iowa, chairman of the Sundry Civil Appropriations Committee and Representative Byrns, of Tennessee, ranking minority member of that committee, in which they urged additions to appropriations. Their arguments were in defense of an item of $125,000 providing for an engineering investigation by the U. S. Geological Survey of the super-power project for the eastern United States. Mr. Byrns stated: "This proposition is one that looks forward to the conservation of our resources and, as has been stated, the time is at hand when something must be done looking to the conservation of our fuel supply because those in authority state that at present the known supply of oil will be exhausted within a very few years at the present rate of consumption." He further characterized this Geological Survey investigation as one that should be made "by government experts in order that if the investigation discloses that such a plan is practicable, those who are asked to make these investments will have confidence in the accuracy and impartiality of the report." Chairman Good in reporting the Sundry Civil bill had already made special reference to the super-power item in the bill as unique but as believed vitally important and he stated that such a survey would represent "Government initiative and cooperation which will result in the savings to the country of hundreds of millions of dollars annually. It will result in a great saving in the direct cost of fuel. It will furnish a reserve source of power for transportation and utility companies, which will be of large value in time of labor disputes and public emergencies. The principle can be applied broadly. Its benefits will accrue to towns and villages and to the farms of the country." Chairman Good also stated that this provision best illustrated the policy of including in the appropriation bill items providing for the fu-

ture. He said "Government can not stand still. It must advance. It must provide for healthy growth of every useful governmental activity." In concluding the debate on this item which was followed by a favorable vote, Chairman Good remarked: "We may smile at this proposition. We may laugh it out of Congress, just as we did by ridicule the proposition of Mr. Langley in regard to the aeroplane."

To those who are interested in scientific and engineering investigations under government auspices such expressions by leaders in Congress are encouraging. It is also worthy of note that neither Mr. Good nor Mr. Byrns represent sections of the country that would primarily and immediately be affected by the proposed investigation; they seem to represent the country as a whole.

AWARD OF THE WILLARD GIBBS MEDAL

The presentation of the Willard Gibbs medal to Dr. Frederick G. Cottrell, director of the United States Bureau of Mines, from the Chicago Section of the American Chemical Society, took place on May 21. This medal was founded by William A. Converse, of Chicago, and is conferred "In recognition and encouragement of eminent research in theoretical and applied chemistry."

At a meeting, which took place in the City Club, Lawrence V. Redman, chairman, addressed the section on The Willard Gibbs medal. The presentation was made by Dr. Willis R. Whitney, director of the Research Laboratories of the General Electric Company, and the Willard Gibbs address on "International scientific relations," was given by Dr. Cottrell.

While a professor at the University of California from 1902 to 1911, Dr. Cottrell devised a process for removing fumes from the waste gases of a sulphuric acid plant at a copper smelter. There had been numerous complaints that the noxious vapors were imperilling the health of the surrounding population, destroying animal life, and injuring vegetation. The process devised by Dr. Cottrell consisted of placing chains at the bottom of the flues. These chains were charged with currents of electricity, the effect of which was to cause the particles to fall and thus prevent their escaping into the air.

Dr. Cottrell patented the device but turned over his rights to a non-dividend-paying organization, formed for that purpose and known as "The Research Corporation." A charge for the use of the process is made and the net profits are devoted to the promotion of scientific research.

THE RETIREMENT OF PROFESSOR FAIRCHILD OF THE UNIVERSITY OF ROCHESTER

Professor Herman Le Roy Fairchild, head of the department of geology and curator of the geological museum at the University of Rochester, reached his seventieth birthday on April 29 and will retire from active service at the close of the present academic year. As a tribute to his contribution to science and his service to the university, undergraduates and members of the faculty joined in paying homage to him. Gifts from his classes and from the faculty expressed the esteem in which Professor Fairchild is held by the undergraduates and his associates on the teaching staff. His entry into the chapel in Anderson Hall on April 29 was the signal for an outburst of applause and cheering, which was renewed on the presentation of the faculty gift.

President Rush Rhees and Professor John R. Slater, head of the department of English, were the speakers. Pointing to Professor Fairchild's successful career as an indication that "a prophet is not without honor in his own country, even if he is a weather prophet," Professor Slater lauded his contribution in the field of science and scholarship, and after reading an original poem written for the occasion presented the faculty gift.

Professor Fairchild received the bachelor of sciences degree from Cornell University in 1874, and the honorary doctorate of science from the University of Pittsburgh in 1910. He was professor of natural science in Wyoming Seminary, at Kingston, Pa., from 1874 to 1876, and from there he went to New York city as a lecturer on natural science and on geology in Cooper Union. He was recording secretary of the New York Academy of Sciences from 1885 to 1888, going to the University of Rochester in that year. He

served as president of the Rochester Academy of Science from 1889 to 1891, secretary of Geological Society of America from 1890 to 1906, and president of the society in 1912. He was chairman of a section of geology of the American Association for the Advancement of Science in 1898 and is a member of its executive committee. Professor Fairchild is an authority in glacial and dynamic geology.

SCIENTIFIC NOTES AND NEWS

PROFESSOR JOHN C. MERRIAM, of the University of California, was elected president of the Carnegie Institution of Washington on May 25, to succeed Dr. R. S. Woodward, who will retire at his own request at the end of the year, after sixteen years of service. Dr. Merriam is professor of paleontology and dean at the University of California. He was last year acting chairman of the National Research Council.

AT the annual meeting of the American Academy of Arts and Sciences held on May 12, it was voted upon the recommendation of the Rumford Committee to award the Rumford Premium to Dr. Irving Langmuir, of the General Electric Co., for his researches in thermionic and allied phenomena.

AT a stated meeting of the Franklin Institute on May 19 the Franklin Medals were presented to Sir Auckland Geddes, British ambassador for the Honorable Sir Charles A. Parsons, Newcastle-on-Tyne and to His Excellency, Mr. A. W. F. Ekengren, minister of Sweden for Professor Svante August Arrhenius, of the Nobel Institute, Stockholm. Papers were read on "Some Reminiscenses of Early Days of Turbine Development," by Sir Charles A. Parsons and on "The World's Energy Supply," by Professor Arrhenius.

THE Société de Pathologie Exotique has elected the following members from the United States: Dr. S. Flexner, Rockefeller Institute, associate member, already corresponding member; Dr. B. H. Ransom, U. S. Bureau of Animal Industry, corresponding member.

PROFESSOR HIRAM BINGHAM has been decorated by the French government with the Ordre de l'Etoile Noire, grade of officer, for his services in France during the war. Dr. Bingham was recently elected an alternate-at-large to the Republican National Convention to be held in Chicago in June.

PROFESSOR A. D. WILSON, director of the division of agricultural extension of the college of agriculture of the University of Minnesota, has declined the post of assistant secretary of agriculture, tendered him by the Secretary of Agriculture, E. T. Meredith.

AT its meeting on May 12 the Rumford Committee of the American Academy of Arts and Sciences voted an appropriation of $200 additional to former appropriations to Professor Norton A. Kent, of Boston University, in aid of his research on spectral lines.

CHARLES W. TRIGG, incumbent of the Coffee Fellowship at the Mellon Institute of Industrial Research, while still retaining his former connection, has moved to Detroit, Michigan, to assume charge of the chemical department of the donors, the King Coffee Products Corporation.

GENERAL W. C. GORGAS has left for England accompanied by Brigadier-General Robert E. Noble. They will proceed to Wset Africa to study what is alleged to be an outbreak of yellow fever in that district.

DR. LOUISE PEARCE, of the Rockefeller Institute for Medical Research, has sailed for England and Belgium *en route* to the Belgian Congo for the purpose of studying the chemotherapy of African sleeping sickness.

MR. FRANK C. BAKER, curator of the Museum of Natural History of the University of Illinois, will spend the months of July and August in making a survey of the molluscan fauna of Winnebago Lake, Wisconsin, in the interests of the Wisconsin Geological and Natural History Survey. Material will also be obtained for the exhibits and research collections of the Illinois University Museum. Winnebago Lake is similar in origin to the large Oneida Lake in New York, which Mr. Baker surveyed several years ago for the College of Forestry at Syracuse University, and a comparison of the faunas of the two bodies

of water is expected to add to our knowledge concerning the life of shallow lakes.

Governor Smith of New York, has announced the appointment of five commissioners of the Enfield Falls Reservation, the property recently conveyed to the state by Mr. and Mrs. Robert H. Treman, of Ithaca. They are Robert H. Treman, giver of the reservation; Liberty Hyde Bailey, of Ithaca, former dean of the New York State College of Agriculture; Mayor Edwin C. Stewart, of Ithaca; George A. Blauvelt, former state senator, and William E. Leffingswell, of Watkins, former assemblyman.

The council of the British Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1919–20: Telford gold medals and Telford premiums to Mr. David Lyell, Mr. J. K. Robertson, and Major-General Sir Girard M. Heath; a George Stephenson gold medal and a Telford premium to Mr. Maurice F. Wilson; a Watt gold medal and a Telford premium to Mr. P. M. Crosthwaite; and Telford premiums to Major E. O. Henrici, Sir Francis J. E. Spring, Mr. F. O. Stanford, Mr. J. Mitchell, Mr. J. W. Sandeman, and Dr. A. R. Fulton.

Dr. Colin G. Fink, of New York, recently lectured before the graduate students in chemistry of Yale University on "The Organic Chemistry of Metal Carbides" and on "Contact Catalysis."

Under the auspices of the Southwestern Division of the American Association for the Advancement of Science, Mrs. M. D. Sullivan gave a lecture, entitled "Scientific Research and the Library," at the Carnegie Public Library of El Paso, Texas, on May 20 and on May 27, Professor Daniel Hull, assistant superintendent of the El Paso High School, gave a lecture on "The Einstein Theory of Relativity," at the Chamber of Commerce.

Dr. E. B. Rosa, chief physicist of the Bureau of Standards delivered an address on May 20 before the Washington Academy of Sciences on "The Economic Value of Scientific Research by the Government."

The Linacre lecture of the University of Cambridge was delivered on May 6, by Dr. Henry Head on "Aphasia and Kindred Disorders of the Speech."

Dr. John Nelson Stockwell, of Cleveland, known for his contributions to mathematical astronomy, at one time professor in the Case School of Applied Science, died on May 18, aged eighty-eight years.

George Gilbert Pond, dean of the School of Natural Science of Pennsylvania State College, died at Hartford. He was born in Holliston, in March 1861. For five years he was instructor in chemistry at Amherst and then became a professor in the same department. He left Amherst to accept the appointment with the Pennsylvania State College.

Dr. H. P. Barrows, who resigned recently as professor of agricultural education at the Oregon Agricultural College and as state supervisor of agricultural education under the Smith-Hughes act to accept the position of federal regional agent for agricultural education with headquarters at San Francisco, died at San Francisco, on May 3.

Deaths of scientific men are recorded in *Nature* as follows: John Alexander McClelland, professor of experimental physics in University College, Dublin, and known for his researches on secondary radio-activity; T. G. Bartholomew, the head of the cartographical firm which has been known since 1899 as the Edinburgh Geographical Institute; Rudolph Messel, president of the Society of Chemical Industry and past vice-president of the Chemical Society, London; L. T. O'Shea, professor of applied chemistry in the University of Sheffield and honorary secretary of the British Institution of Mining Engineers, and A. K. Huntington, emeritus professor of metallurgy at King's College, London.

The Civil Service Commission announces an examination for supervising metallurgist. A vacancy in the Bureau of Mines, Department of the Interior, for service in the field, at $4,000 to $5,000 a year, will be filled from this examination.

THE U. S. Civil Service Commission announces an examination for assistant for fishery food laboratory. A vacancy in the Bureau of Fisheries, Department of Commerce, Washington, D. C., at $2,000 to $2,400 a year, and vacancies in positions requiring similar qualifications, will be filled from this examination. The duties of appointees will be to make analyses of fishery products, including canned products, oils, fish scrap, fish meal, etc., and to aid in the technology of development of methods of preservation and utilization of fishery products in the laboratory and in the field. Competitors will not be required to report for examination at any place, but will be rated on education, experience and a thesis.

THE Ellen Richards Research prize offered by an association of American college women, hitherto known as the Naples Table Association, is available for the year 1921. This is the tenth prize offered. The prize has been awarded four times, twice to American women and twice to English women. The competition is open to any woman in the world who presents a thesis written in English. The thesis must represent new observations and new conclusions based upon laboratory research.

THE Indiana Academy of Science held its annual spring meeting at the McCormack's Creek Gorge State Park near Spencer, Ind., on May 13 and 14. At the business meeting on the thirteenth the academy voted to direct the officers to prepare a suitable clause amending the constitution of the academy, so that affiliation with the American Association for the Advancement of Science would be possible. Final action on this matter will, in all probability, be taken at the regular winter meeting next December. The academy members dined together in the dining rooms of the Christian Church at Spencer on the evening of the thirteenth and early the next morning proceeded by automobile to the State Park, where, under the leadership of Professor Malott, of Indiana University, who has made a special study of the region, the members explored the Flatwoods district and the gorge of McCormack's creek, which drains it. Professors Mottier and Scott, of Indiana University, led the botanists and zoologists on the trip.

DURING the past year the following papers have been presented before the Society of the Sigma Xi at the University of California under the presidency of Professor Herbert M. Evans:

September 27, *Research behind the battle line:* J. H. HILDEBRAND.

October 29, *The processes of social phenomena:* A. L. KROEBER.

November 20, *A study of anger and pugnacity:* G. M. STRATTON.

December 9, *Low temperature research:* W. H. RODEBUSH.

January 28, *Hookworm and military efficiency:* C. A. KOFOID.

February 18, *The effect of alkali on plants:* D. R. HOAGLAND.

March 3, *On the construction of a geological scale for the Great Basin of North America:* J. C. MERRIAM.

March 24, *Physiological studies on aviators:* J. L. WHITNEY.

April 21, *Recent research in the organic compounds of nitrogen:* T. D. STEWART.

May 5, *Some aspects of the development of the anatomical sciences in America:* H. H. EVANS.

CREATION of a Canadian Bureau of Scientific Research, at an initial cost of $600,000 for the site and construction and equipment of the building, and $50,000 for the first year's salaries and upkeep, has been endorsed. The leader of the Government and of the Opposition both supported it. The standardization of all measures used in Canada of length, volume, weight, etc., of all forms of energy and of scientific apparatus used in industry and the public services will be one of the main functions of the Bureau of Research.

THE *Journal* of the American Medical Association quotes from the *Progresos de la Clínica* of Madrid giving the royal decree establishing the Instituto Cajal as a center for scientific research in different branches of biology, and to prepare students to carry on research in other countries. The institute is also to offer facilities to a limited number of foreign re-

search workers, especially those from Latin America, and will invite foreign professors to lecture on their specialties. The new institution will include the laboratories already installed in 1901 for biologic research and the laboratories maintained for research on experimental physiology, neuropathology and histology. A new building is planned and the whole will form a part of the National Institute of Sciences.

In order to stimulate more general research along the lines of better preparation and packing of foods and beverages, and to increase our knowledge of such changes induced by preparation or storage of such products, the Glass Container Association of America, Dr. A. W. Bitting, director of research, 3344 Michigan Avenue, Chicago, Ill., will make seven awards in value from $50 to $150 for theses submitted prior to June 10, 1921. A thesis may cover any phase of the subject of foods or beverages—technological, bacteriological, or chemical. It may treat of any legitimate method of preparation, as sterilization by heat, pasteurization, salting, drying, smoking, pickling, sugaring, etc., the product to be packed in glass. The thesis may be bibliographical with abstracts, or may be a translation from work along the lines indicated. Any student working for a degree in any college or university is eligible to compete.

The proceedings of the Paris Congress of Physiology under the presidency of Professor Charles Richet, will begin on Friday, July 16, and will end on the following Tuesday. The last congress was held at Groningen in September, 1913, and it was then decided that the next should be held in Paris. The subscription (35 francs) should be sent to M. Lucien Bull, l'Institut Marey, Avenue Victor-Hugo, Boulogne-sur-Seine (Seine).

UNIVERSITY AND EDUCATIONAL NEWS

In recognition of the great and increasing need for competent specialists in the medical sciences, a new course leading to the degree of doctor of medical sciences (D.M.S.) has been established at the Harvard Medical School. The first two years' work of this course is substantially identical with that of the regular medical students and this general training in the medical sciences is followed by a minimum of two years of concentration work in one of the laboratory departments. The qualifications and character of work required of those admitted to the concentration course are essentially the same as for Ph.D. students. The granting of the D.M.S. degree will be based on the same standard.

It has been planned for some time to found a university at Cologne. *The Journal* of the American Medical Association reports that the necessary formalities were complied with last year, and the new university has recently come into being very quietly. The various colleges and institutes have thus been collected into a state university which offers a chance to relieve the overcrowding of the university at Bonn. The new university starts with 2,000 students and over forty instructors.

Professor Cecil H. Peabody, head of the department of naval architecture, the Massachusetts Institute of Technology, has resigned after thirty-seven years. Dr. Peabody has been in charge of the marine engineering course since its formation in 1883. Professor J. R. Jack will succeed Professor Peabody.

Dr. William E. Ford, of Yale University, has been promoted to a professorship of mineralogy and has been made a member of the governing board of the Sheffield Scientific School.

Dr. H. E. Wells, formerly professor of chemistry at Washington and Jefferson College and captain in the Chemical Warfare Service, U. S. A., has been appointed professor of chemistry at Smith College.

Dr. J. P. Musselman, of Washington University, St. Louis, has been appointed associate in mathematics at the Johns Hopkins University. Dr. Musselman is the national president of the Gamma Alpha Graduate Scientific Fraternity.

DISCUSSION AND CORRESPONDENCE

"PETROLIFEROUS PROVINCES"

IN a discussion of Petroliferous Provinces in a recent number of *Mining and Metallurgy*,[1] Dr. Charles Schuchert has quoted from an article on "Some Factors in the Geographic Distribution of Petroleum"[2] by the present writer, and has drawn certain conclusions and made certain inferences which are decidedly at variance with the ideas the author intended to convey. In order that some of the apparently ambiguous statements in the article on Geographic Distribution should not be generally misconstrued, it is desired to call attention to certain points which the reviewer has apparently overlooked.

Dr. Schuchert says:

> Since the previous paragraph was written there appeared the suggestive paper by Mehl, already cited, in which he points out that all the major oil fields of the world are situated between 20° and 50° north latitude. Further, that there are no major oil areas within the tropics or in the southern hemisphere. As the known major oil fields lie between the present isotherms of 40° and 70° F., he thinks that this distribution "does suggest a distinctly zonal distribution of petroleum in which temperature may have been an important factor." The question that here arises is, Is this suggestion of present climatic conditions also true for the times when the oil was deposited in the strata in which it is now found, remembering that the oil fields were not made recently but are the accumulations of hydrocarbons of the seas of geologic ages? The answer is not at all in harmony with Mehl's suggestion, for we are living in an exceptional time of stressed climates and marked zonal conditions, while the mean temperature conditions during the geologic ages were warm and equable throughout most of the world, and this is even more true of the temperature of oceans than of the lands.

The paragraph that called forth this comment follows:

> Attention is further called to the general correspondence between the position of the twentieth and fiftieth parallels in both hemispheres with the average annual isotherms of 70° and 40° respectively. Although these parallels are, in reality, nothing more than imaginary lines of geographic references, *each does, in much probability, mark the average position of some isotherm as it has shifted in past geologic times.* While the disposition of maximum accumulations as here bounded does not indicate a definite temperature zone within which petroleum has been formed, it does suggest a distinctly zonal distribution of petroleum in which temperature may have been an important factor.

There follows a few paragraphs further on:

> Very often the rapid decay of organisms is pointed to as illustrating the manner in which petroleum is formed. In certain parts of the Mediterranean Sea, for instance, the accumulation and decay of organic detritus is so rapid that the lower levels of the water are filled with scattered globules of oil. *Instead of illustrating how petroleum is formed, however, it points to the effective manner in which fatty matter is ordinarily separated out from accumulating sediments. Certainly, the globules which are escaping into the water offer no suggestion of being retrapped and converted into petroleum.* It is only that part of the organic matter which is converted into oil so slowly that the accumulating sediments form a sufficient thickness and suitable succession to retain it against the tendency of the associated waters to drive it off, that may become petroleum.

So much has been added to our knowledge of the climates of past geological ages by the work of Dr. Schuchert and others that it does not seem appropriate, in an article not intended primarily for the beginning student in geology, to call attention to the fact that the present average annual isotherms are not necessarily coincident with the same isotherms throughout past geologic periods. Furthermore, it would appear that one might logically take for granted a general knowledge of the principles underlying temperature zones and the nature of their boundary lines as follows:

1. The sinuosity of isotherms is determined largely by the extent of the land masses and their configuration.

[1] *Bull. Amer. Inst. Mining and Metallurgical Engineers*, No. 155, pp. 3058–3070, November, 1919.

[2] *Bull. Scientific Laboratories, Dennison Univ.*, Vol. XIX., pp. 55–63, June, 1919.

2. In general, the more widespread the oceans the less sinuous the isotherms.

3. During periods of more nearly universal oceans, the closer the parallelism between isotherms and parallels.

It would appear that the logical conclusions to be drawn from the two immediately preceding quotations, providing we may take for granted a knowledge of the general conditions of past climates, are as follows:

1. The belt between the parallels 20° and 50° north latitude was, during the periods when the petroleum of the zone was forming, some definite temperature zone the boundaries of which, the average annual isotherms, were essentially coincident with the parallels.

2. The temperatures of this zone very likely fluctuated within a single period and showed more or less marked differences from period to period.

3. The average of the fluctuating temperatures for this zone was not necessarily the same as that of this belt for the present time, viz., 40°–70° F.

4. The only reference to the formation of petroleum in this zone at present day temperatures (the Mediterranean Sea) *does not* illustrate the manner in which petroleum is formed.

The obvious inference of these conclusions is that could we determine the exact temperature conditions under which petroleum is formed there would be available another means of testing the temperatures of the various areas in which the petroleum was formed, during the periods when it was forming. In other words, some estimate could be made of the average temperature of the "petroleum zone"—that belt bounded by the parallels 20° and 50° north latitude—during the "petroleum periods."

There is one more point on which the present writer's view was, perhaps, not adequately stated, although his intention would seem to be clear. The following is from Dr. Schuchert's criticism:

> . . . The writer also knows that hydrocarbons have accumulated in large amounts in seas within the tropics, yet seemingly the amount is far the greatest in what is now the north temperate zone. That this zone has the greatest amount of petroleum is apparently due wholly to the greater land masses here, along with the necessary storage strata accompanied by the proper amount of deformation.
>
> Even if Mehl's suggestion were correct, and we should accordingly think of next exploiting the temperature region of the southern hemisphere, we must not overlook the fact that the northern hemisphere is a land hemisphere, while the southern one is a water hemisphere, and therefore has greatly reduced continents.

To quote from the article on "Geographic Distribution":

> Regardless of the lack of thorough prospecting, however, there is reason to believe that of the three zones, the equatorial belt between the twentieth parallels and adjacent belts in the northern and southern hemispheres extending north and south to the fiftieth parallels, the northern belt will, when investigations are carried to completion, be found the more productive. For instance, one may safely assert that, all other factors being equal, the amount of petroleum underlying a given area is directly proportional to the size of that area. It is evident that in the area of exposed lands neither the southern nor the equatorial belts compare favorably with the northern zone.

And again, in summarizing:

> If we may grant, then, that within a limited zone, the equatorial belt, conditions have been unfavorable for the formation of accumulations of petroleum, on the average, it is logical to seek a belt in the southern hemisphere suitable for such deposits, to correspond with the belt in the northern hemisphere. *Were the temperature factors alone to be considered, there is little doubt but that much might be expected from the southern zone. It has already been pointed out, however, that the area of exposed land within this zone is relatively small and of this a very large proportion consists of Pre-Cambrian or igneous rocks. Apparently little more is to be expected from the southern belt than from the equatorial zone.*

As the writer stated in the article quoted by Dr. Schuchert, it was hoped "that the speculations would call forth a discussion of the principles involved and possibly stimulate investigations in the several branches of science interested." He was much surprised to learn

that these principles had been so stated as to convey a meaning quite different from that intended. It is hoped that these notes concerning the writer's statements that have been criticized will throw a somewhat different light on their interpretation.

MAURICE G. MEHL
UNIVERSITY OF MISSOURI

AN IMPROVED METHOD OF HOLDING LARGE SPECIMENS FOR DISSECTION

MR. JOHN M. LONG[1] recently published a scheme for holding large specimens open while dissecting them in which he uses "trays of galvanized iron with four or more loops of metal soldered on the sides to which ordinary heavy rubber bands are attached. To these rubber bands are tied small fishhooks which have had their barbs filed off. These hooks are to be fastened to any part of the anatomy so as to hold the specimen firmly, or to pull certain parts to the desired position." As these rubber bands with the sharp fishhooks attached are permanently tied to the sides of the trays, there is some danger and inconvenience in handling the latter. This difficulty can be overcome and the whole scheme improved upon by fastening small, blunt hooks to the rubber bands at the opposite ends from the fishhooks, thus making them so that they can be easily removed from the trays. It is also a good idea to file the points of the fishhooks down somewhat so that they are not so dangerous to handle, and yet they can be easily thrust through the skin or flesh of the specimen to be held.

HORACE GUNTHORP
WASHBURN COLLEGE,
TOPEKA, KANS.

SCIENTIFIC BOOKS

South. The Story of Shackleton's Last Expedition, 1914–1917. By SIR ERNEST SHACKLETON, C.V.O. With 88 illustrations and diagrams. The Macmillan Company, New York, 1920. $6.00.

It has been well said that peace has its victories as great as those of war. Too much praise can not be given the men who for country alone, or for the whole world, have struggled and suffered, bled or died. But peace, not war, is the normal phase of our life, and its unwarlike victories—material, mental and spiritual—most deeply affect us. For this reason the world delights to read this straightforward tale of Shackleton, wherein are embodied high adventure, unique experiences and thrilling situations with displays of courage and persistence, of fidelity and solidarity—qualities which ennoble mankind.

The scientific work in view was the most comprehensive and ambitious ever attempted by a polar expedition. In extent and importance it approached, if it did not surpass, the International Polar Conference program of 1881–1884. Geographically the vast ice-clad continent of Antarctica was to be crossed from Weddell Sea to Ross Sea, and its glacier-lined, unknown coasts charted by cruises in unvisited waters of the Antarctic Ocean. Scientifically were to be studied the fauna of the sea, the hydrography of the ocean, the geology of the land, the meteorology of the air, and the mysteries of magnetism. The primary base, under Shackleton personally, was to be established near Vachsel Bay, Luitpold Land, discovered in Weddell Sea by Filchner in 1912.

It is of special interest that this south-polar area, through the comprehensive policy and timely application of England's colonial methods, is a part of her empire. By proclamation of July, 1908, this region was declared to be British territory which was defined as "Situated in the South Atlantic Ocean to the south of the 50th parallel of south latitude and lying between 20 degrees and 80 degrees west longitude."

The second party—to enter Ross Sea—will be later considered. Sailing from Plymouth, August 8, 1914, after the Admiralty had declined the offer for war purposes of his ship *Endurance,* Shackleton made his final arrangements at Grytvikin, South Georgia whence he steamed south on December 5. His ship was fitted for every contingency, and his crew

[1] SCIENCE, Vol. XLIX., pp. 120–121.

of 28 were men selected from nearly 5,000 volunteers, eager for polar adventure.

Two days later the ship entered the pack which was found very far north, and proved to be increasingly unfavorable. Five hundred bergs were passed in a single day, and the *Endurance* sailed over the projecting foot of a berg 150 feet high. After steaming over 700 miles through the pack Coats Land, discovered by Bruce in the *Scotia,* 1904, was sighted from 72° 20′ S. on January 10, 1915. This land was skirted its entire length, from 72° 34′ S., 16° 40′ W., to about 74° 04′ S. 22° 48′ W. Beyond this coast Shackleton discovered new land, which he named Caird Coast, which he followed about 200 miles to its junction with Leopold Coast of Filchner, 1912. The extreme northerly point of Caird Coast is in about 73° 20′ S., 26° W. and the southern point in 76° 30′ S., 28° W.

Shackleton thus describes it: "It is fronted by an undulating barrier, which terminates usually in cliffs ranging from 10 to 300 feet in height, but in a very few places sweeps down level with the sea. At the southern end of Caird Coast the ice-sheet, undulating over the hidden and imprisoned land, is bursting down a steep slope in tremendous glaciers bristling with ridges of ice and seamed by thousands of crevasses. Along the whole length of the coast we have seen no bare land or rock. Not as much as a solitary nunatak has appeared."

On January 18, 1915, the *Endurance* was beset in the pack, in 76° 34′ S., 31° 30′ W., never to be released. Thus ended the chance of landing and of crossing Antarctica. This besetment occurred in midsummer, when unusually low temperatures of zero and below were observed.

Held fast the ship drifted with the main ice-pack and reached an extreme southing of 77° S. 35° W. The drift was first to the west and then to the north-by-west attaining April 9, 1916, 62° S., 54° W. Crushed by the ice the *Endurance* sank November 21, 1916, in 69° S., 53° W. when the crew took to the ice. They were then 346 miles from Paulet Island, the nearest place of safety, which two separate attempts to reach, by travel over the ice-floes, proved impossible of attainment. They were forced to depend on the northerly drift of the main pack for safety. Their drift life of four and a half months was marked by vicissitudes and miseries inseparable from storms, with tent-shelter only, and lack of heat. Food was also insufficient, their daily ration for a while being below ten ounces of food, and despite continuous hunting they finally were forced to eat their dogs. Storms were frequent and one blizzard caused intense suffering with temperatures of 21 to 34 degrees below zero. Dredging, soundings, weather observations, hunting and games were carried on in such manner as to preserve the morale of the men.

There had been a northerly drift of about 1,500 miles, making good a northing of 573 miles before the *Endurance* sank. This drift continued until the end of the antarctic summer, in March, found them outside of the antarctic circle and in sight of Joinville Island, with the close ice-pack so disintegrated as to make travel thereto impossible, either by boat or by sledge. On April 7, 1916, after the breaking up of floes had several times threatened the loss of boats and party they sighted Elephant Island. Launching their three boats under conditions of great and continuing danger they were day after day obliged to take refuge from closing ice on the nearest floe or berg of size. Almost as by miracle they reached and landed on glacier-covered Elephant Island, where a narrow fringe of tide-swept beach was the only visible land. Fortunately penguins and seal were present in such numbers as to save them from immediate starvation. With coming winter there was such danger of the party perishing that Shackleton with five men sought relief from South Georgia, over 800 miles distant. This journey, across the most tempestous storm-swept southern ocean in approaching winter, and the crossing of South Georgia by land, are among the most thrilling experiences in polar history. Tortured by thirst, benumbed by cold, water-soaked whether on duty or in their sleeping bags, their skill as

navigators was all that enabled them to make the journey, while they were exhausted by the necessity of bailing the boat continuously for days, to keep her from swamping under pouring sprays and whelming waves.

Four relief expeditions were necessary under Shackleton before the party on Elephant Island were rescued. Through the energy and direction of Frank Wild, the marooned party of 22 men lived through four and a half months of winter in huts with stone walls, and boat-covered, as had been done by the Greely Arctic Expedition at Cape Sabibe in the winter of 1883–1884.

At Elephant Island the food supply was limited almost to a starvation point, though their regular food was supplemented by penguins, seals, seaweed and sea-limpets. While the Weddell Sea scientific observations have not been published some items of interest are given in this narrative. In 77° S. 34° W. the magnetic variation was found to be six degrees west; auroras were rare. Meteorologically clear sky increased steadily from 7 per cent. in January to 45.7 in July; it decreased to below 30 from September to November and nearly to zero in December. Temperatures were fairly high, the minimum for the year being 35 degrees below zero in July. Generally southerly winds brought clear weather with low temperatures, while the reverse conditions obtained with northerly winds. The ice-drift, due partly to currents but more largely to winds of Weddell Sea, is contrary to the movements of the hands of a watch. Doubtless it conforms almost entirely to a course nearly parallel to the general contours of the land masses of Antarctica. Geographically the only direct contribution is the connection of Coats Land and Luitpold Land, which determines the continuity of the continent of Antarctica from 6 to 43 degrees west longitude, and from 72.5 to 78 degrees south latitude. The North Greenland of Morrell disappeared long since from charts, but the reviewer's belief, in his Hand-Book of Polar Discoveries, that Morrell's longitudes were to blame would throw this land some 12 degrees west to Palmer or Graham Land. Astronomical observations proved that Shackleton's chronometer longitudes were one degree in error. Again he throws Foyn coast two degrees to the west of its reported position, and states that his observations place Sanders Island three miles east and five miles north of its charted position. These corrections indicate clearly the liability of explorers, unless highly skilled, to material errors when making observations under abnormal and difficult conditions. Hydrographically Weddell Sea is very deep, averaging in the large over 2,000 fathoms. Shackleton mentions three soundings of 2,400, 2,810 and 2,819 fathoms. He mentions the shoaling of the sea as he drifted "north either to east or west, from 77° S., and the fact suggested that the contour lines ran east and west roughly." The reviewer thinks that this indicates the existence of a continental shelf, off land trending westerly along the 77th parallel, and changing to north-northwest between longitudes 55° and 60° west.

The summary of Lieutenant Clark on the whaling industry of the Dependencies of the Falkland Islands is of special interest. The total value of the fisheries, in pounds sterling, were: 1913, 1,252,342; 1914, 1,300,978; 1915, 1,333,401 and in 1916, 1,774,570. In 1916 11,860 whales were captured in this area. The industry is now dependent on large fin and blue whales, humpbacks having been largely reduced in numbers.

The Ross Sea story is one of heroic effort not unmixed with disaster. The *Aurora,* Captain Mackintosh, left Hobart in December, 1914, and reached Cape Evans January 16, 1915, and after preliminary movements went into winter-quarters. While Mackintosh was absent, and all stores for the expedition not yet landed, the *Aurora* was forced by a violent blizzard into the pack on May 6, 1915, and drifting north was not able to clear the pack until March 14, 1916, in 62° 28′ S., 158° W. The marooned party, ten men only, by heroic effort, succeeded in establishing, as planned, a supply depot for the party which was expected to cross Antarctica from Weddell Sea. This depot was laid down at the base of Mt.

Hope, at the foot of the Beardmore, Glacier, in 83° 30′ S. These field parties in 160 days traveled 1,561 miles, of which distance 830 miles were made in laying down from Hunt Point the depot at Mt. Hope. Scurvy attacked the main party in the field and one man, Spencer Smith, died the day before their return journey was completed. Later Captain Mackintosh and Hayward perished in a blizzard during a short journey—probably from disruption of the ice-pack. Shackleton went at once to the rescue of this party, sailing in the *Aurora,* which was commanded by the veteran polar captain, Davis, in December, 1916. The voyage was short and the marooned men were brought safely to Hobart.

The illustrations are of unusual value, conveying as they do a clearer and more accurate view of polar scenes and lands, and especially as to Caird Coast and Elephant Island. The set illustrating various types of ice are important, and should become standard.

The narrative is marked by its appreciation of the members of the two expeditions, and from it one is confirmed in the realization that Shackleton is a leader of men of unusual ability and force. Considerate of his subordinates, he never spared himself, and under a less able leader the Weddell Sea party would have perished.

A. W. Greely

SPECIAL ARTICLES

THE ASH OF DUNE PLANTS

Sand, the final residue after weather and water have worked their will on the silicate rocks, is possibly the poorest substratum in a chemical sense for the growth of plants. Under the action of glaciers and running water followed or accompanied by the hydrolyzing action of water in the presence of carbon dioxide and lastly subjected to the monotonous attrition of particle against particle acutated by wave motion, nothing is left of the original rock masses except partially rounded particles of quartz accompanied by grains of the more resistant silicate minerals and magnetic oxide of iron (Fe_3O_4). The finely divided silt and clay produced during the formation of the sand by wave abrasion and containing the most valuable mineral constituents for plant growth, consisting as they do of particles approaching colloidal dimensions, remain easily in suspension and are carried away by very slight water currents to be deposited far apart from the sand in quiet places. That which remains with the sand after deposition on beach or shore is carried away by the wind and redeposited at a distance, so that beach, shore or dune sand contains a minimal quantity of clay—not enough in a handful to cloud a tumbler of water.

In ordinary sand the silica content varies from approximately 92 to 98 per cent. A part of this exists free as quartz and a part in combination in silicate minerals which have resisted decomposition. The following analyses from Clarke[1] show the composition of sands from various sources.

	A	*B*	*C*	*D*	*E*	*F*
SiO_2	77.78	90.74	82.13	89.99	55.03	91.39
Al_2O_3	9.95	5.16	9.04	7.36	14.12	5.44
Fe_2O_3	2.55	1.14	2.94	.72	10.15	.89
FeO	.21	.08	.....	.13	.....	.16
MnO	.....	Trace	.....	Trace	.....	Trace
OaO	.71	.69	1.28	.46	6.88	Trace
MgO	.17	Trace	.84	Trace	6.38	Trace
K_2O	2.50	1.19	1.93	.33	1.66	1.19
Na_2O	1.82	.26	.95	.33	.87	.70
P_2O_5	.....	.....	.20	.....	.....	.....
Ignition	2.74	1.30	1.01	.60	4.55	.65
	98.43	100.56	100.01	100.43	99.64	100.42

A, B. Glacial sands.
C. Average of five river sands.
D. Sea sand.
E. Sea sand derived from subsilicic igneous rocks.
F. Blown sand.

In spite of its chemical poverty and its inadequacy as a soil for the support of nearly all agricultural plants, sand, nevertheless, has certain physical advantages which are of importance and valuable to such vegetation as

[1] "The Data of Geochemistry," by F. W. Clarke, Bull. 616, U. S. Geological Survey.

can maintain life on low mineral rations; (1) on account of its porosity it is always well drained; (2) it is likewise well aerated; (3) it allows free lateral and vertical movement of ground water; (4) on account of its low capillary absorption of water it has a very low wilting limit;[2] in other words, it

	Water per 100 of Dry Soil When Plants Wilt	Hygroscopic Water
Coarse sand	1.5	1.15
Sandy garden soil	4.6	3.00
Fine sand, with humus.	6.2	3.98
Sandy loam	7.8	5.74
Chalky loam	9.8	5.20
Peat	49.7	42.30

gives up its water readily to plants and even though it contains little, that little is available for the growth of vegetation; (5) it offers little obstruction to the growth and extension of roots, when compared with stiffer soils such as clay loams and clay.

Probably its greatest physical disadvantage is its tendency to drift with the wind with the resultant root-uncovering or top-burying action. However, this is not a serious menace to typical dune vegetation for the great root systems of most dune plants permit uncovering in some degree while even a continuous "hilling-up" of most of them during their growth appears to work no harm.

The dune region of Northern Indiana along the south shore of Lake Michigan, with which the writer is most familiar, has been the subject of numerous botanical as well as general investigations, and has attracted much interest recently since the proposal has been made to establish a National Park there. Cowles in a series of interesting papers[3] has discussed the plant ecology of the region and Shelford[4] the animal ecology.

[2] A. D. Hall, "The Soil," p .85.

[3] "Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan," *Bot. Gaz.*, 27, pp. 95, 167, 281, 361 (1899). Also "Plant Societies of Chicago and Vicinity," Bull. 2. Geog. Soc. of Chicago.

[4] "Animal Communities in Temperate America," Bull. No. 5. Geog. Soc. of Chicago.

The variety of plants in the district between Gary and Michigan City and extending about 1 or 1½ miles back from the lake shore is very great. The storm beach, to the upper limit of storm waves and driftwood (the region of the "singing sands") practically devoid of vegetation, is usually about 40 to 100 feet wide, but naturally varies with the season and wind intensity. There may be a few quick growing annuals such as sea kale (*Cakile americana*), bugseed (*Corispermum hyssopifolium*), etc., in this belt, especially during a few weeks of summer calm. Between the storm beach and the fixed dunes lies the belt of young dunes in the making, and here grow both annuals and perennials. The sand cherry (*Prunus pumila*) is here, perhaps of all the most characteristic shrub, but along the same stretch grow red osier dogwood (*Cornus stolonifera*), cotton woods (*Populus deltoides*), low willows (*Salix glaucophylla, Salix adenophylla*), artemesia (*Artemesia caudata*), Pitcher's thistle (*Cirsium Pitcheri*), the grasses, *Calamovilfa longifolia* (abundant) and *Ammophila arenaria* (less abundant. *Andropogon scoparius* (*littoralis*) does not grow as a rule near the storm beach but higher up on the fixed or partially fixed dunes.

Back of the storm beach and the embryonic dunes rise the permanent or wooded dunes, well fixed by vegetation, except where blowouts have cut through and started the sands to drifting once more. In some places the fixed dunes rise abruptly from the rather narrow storm beach, and in others low, moving or semi-fixed dunes run back from the shore for long distances. But the first example is typical.

Usually in the region discussed the shore consists of the fine sand described with relatively little shingle, but after a succession of severe storms as during the past two years, the amount of shingle increases until the shore is covered with it for a width of ten to forty feet. Undoubtedly this assists in holding the sand and preventing its drifting.

The sand of the northern Indiana dune region is considerably finer than that of some

others, for example Cape Cod, and in fact the entire Atlantic coast, drifts easier with the wind and is less stable unless indeed it is stabilized by growing vegetation. A rough sieve analysis gives the following proximate physical composition, the percentages shown being the amounts passing or retained on sieves of the indicated mesh.

PHYSICAL ANALYSIS LAKE MICHIGAN SAND

	Shore Sand	Dune Sand
Finer than 100 mesh ..	3.3	3.4
Finer than 80 mesh....	9.4	11.3
Finer than 60 mesh....	49.2	46.3
Coarser than 60 mesh..	50.8	53.7

When examined chemically the sand shows no remarkable peculiarity with the possible exception of a rather high percentage of calcium which may be accounted for by the fact that the native rock of the region is limestone and the gravel of the boulder clay of the west shore of the lake is composed largely of the same rock. Analyses of the shore sand and of the dune sand give results which are practically identical. The following analyses were made in 1911.[5]

CHEMICAL ANALYSIS OF SHORES AND DUNE SAND

	Shore Sand	Dune Sand
Loss on ignition	1.00	0.90
Silica	92.00	91.90
Iron and Al. oxides...	3.24	4.30
Calcium oxide	1.36	1.36
Magnesium oxide	0.56	0.72
Sodium oxide	0.47	0.63
Potassium oxide	0.85	1.00

Another analysis of sand from a blowout was made in 1918 and gave the following results:

ANALYSIS OF SAND FROM BLOWOUT

Silica (SiO_2)	90.28
Iron oxide (Fe_2O_3)	1.03
Aluminum oxide (Al_2O_3)	3.55
Calcium oxide (CaO)	1.57
Magnesium oxide (MgO)	0.73
Sodium oxide (Na_2O)	2.22
Potassium oxide (K_2O)	1.05
Phosphoric anhydride (P_2O_5)	trace, less than 0.01%

[5] Analyses by L. S. Paddock.

Approximately 90 to 92 per cent. of the sand is silica but it should be remembered that the remaining 8 to 10 per cent. consisting of calcium, magnesium, iron, aluminium, sodium, potassium, etc., is contained in undecomposed silicate minerals. Under the hand lens, while the clear white, yellow or red sand quartz grains greatly predominate, there is present also, in characteristic fashion, a considerable proportion of bright-colored and dark particles, red, brown, green and black feldspar, mica, hornblende, magnetite, etc., making up, let us say, approximately 25 per cent. of the total. From these particles the dune plants must in the main derive their supply of soluble inorganic substances necessary for nutrition. It should be noted that these rock particles are practically in their unaltered condition, any decomposed or finely disintegrated portions having been mostly dissolved or washed away by the waves or blown away by the wind. However, when the sand is agitated with water there is always present a very small quantity of colloidal particles or clay which is undoubtedly important for the growth of plants. The amount, however, is so slight that it scarcely fails to leave the water clear and could be entirely disregarded for the purpose of the argument.

The integration of chemical infinitesimals by the living organism is not an isolated or unique phenomenon, particularly in the vegetable world. It is nevertheless a matter of the greatest interest, whether it consists in the elaboration of complex carbon compounds from the carbon dioxide of the atmosphere, wherein this substance occurs at a dilution of about 3 parts in 10,000, or the concentration of potassium salts by the giant kelps of the Pacific (*Macrocystis, Pelagophycus, Nereocystis,* etc.) from sea water which contains about 4 parts potassium per 10,000 or only about 1/30 the amount of sodium present; but in the two instances cited, the raw material is brought to the plant in suitable quantity and form of combination, if in a condition of great dilution, from the enormous

reservoirs of air and ocean. In the case of dune plants the root systems must go after their mineral food supply and search the sand grains for it. Not only this, they must convert the needed portions of insoluble silicates into soluble compounds suitable for absorption and metabolism. This they are well equipped to do; for whatever other characteristics various species of dune plants may have and howsoever greatly they differ from one another, they are alike in possessing extraordinary root systems. This does not mean that all the root sytems belong to one type or class but that all are of relatively large dimensions and well adapted to exploring for their food supply or failing this to storing up a supply by slow accumulations through the year for a brief season of active growth or short blooming period—for example, the bird-foot violet (*Viola pedata*). The distances which some of the longer roots travel, horizontally, parallel with the surface, or in a downward direction, are astonishing and all but unbelievable unless one has traced such roots by pulling them out; distances to be measured in units of yards or rods rather than feet or inches. Even quick-growing annuals like sea kale (*Cakile americana*) will send out horizontal root branches in length many times the height of the plant—a plant ten inches high may have horizontal root branches ten feet long.

For the determination of ash constituents, seven typical species were selected. The sand cherry (*Prunus pumila*), artemesia (*Artemesia caudata*), black oak (*Quercus coccinea tinctoria*), the three grasses, *Calamovilfa*, *Ammophila* and *Andropogon*, and the scouring rush (*Equisetum hyemale* var. *intermedium*).

The sand cherry sample consisted of stems and a few leaves, the artemesia of stems, leaves and seeds, the oak of a section of trunk, the grasses of stems, leaves and seeds, and the scouring rush of stems. These were first carefully burned on clean iron pans to a blackish or gray ash, then taken to the laboratory and the ashing completed at a moderate red heat in muffles. The analyses follow:[6]

ANALYSIS OF ASH FROM ARTEMESIA AND PRUNUS

	Artemisia	Prunus
Silica	12.12	1.50
Iron oxide (Fe_2O_3)	1.74	0.71
Aluminum oxide (Al_2O_3)	0.42	0.02
Calcium oxide (CaO)	35.47	44.13
Magnesium oxide (MgO)	6.41	4.25
Phosphoric anhydride (P_2O_5)	3.95	3.25
Carbon dioxide (CO_2)	21.40	35.48
Mangano-manganic oxide (Mn_3O_4)	0.12	0.06
Chlorine present as chlorides	1.75	0.26
Sulphuric anhydride (SO_3)	6.00	0.79
Sodium oxide (Na_2O)	0.52	0.40
Potassium oxide (K_2O)	11.61	10.94

ANALYSIS OF ASH FROM QUERCUS AND COMMERCIAL SAWDUST

	Quercus	Sawdust
Silica	32.38	12.84
Iron oxide	1.50	2.55
Aluminum oxide	0.70	3.05
Mangano manganic oxide (Mn_3O_4)	0.24	0.72
Phosphoric anhydride	0.91	1.40
Sulphuric anhydride	3.33	2.09
Carbon dioxide	18.04	22.40
Chlorine present as chlorides	trace	trace
Calcium oxide	28.86	36.00
Magnesium oxide	3.42	4.13
Potassium oxide	9.51	13.39
Sodium oxide	0.82	1.26

ANALYSIS OF ASH FROM FOUR DUNE PLANTS

	Equisetum	*Calamovilfa* Ash	*Andropogon* Ash	*Ammophila* Ash
Silica	49.44	58.74	65.40	48.56
Iron oxide	1.04	1.61	2.52	2.85
Aluminum oxide	2.26	1.69	2.57	3.02
Calcium oxide	13.36	11.61	10.19	19.00
Magnesium oxide	3.67	3.72	3.21	4.29
Potassium oxide	6.01	10.70	6.68	6.32
Sodium oxide	10.37	4.52	4.00	8.18
*Chlorine	3.83	1.83	2.57	1.10
Sulphuric anhydride	8.97	4.58	1.55	4.95
Phosphoric anhydride	2.55	2.04	2.04	2.05
*Oxygen equivalent	0.86	0.40	0.55	0.25

For comparison with the black oak ash, an analysis was made of the ash on a sample of ordinary commercial oak sawdust, source and

[6] I am indebted to Messrs. L. S. Paddock and W. B. Cochrane for the analytical work on the ash of the various dune plants.

soil unknown This sawdust would represent a mixture of samples from numerous trees and possibly represent several species grown on ordinary forest soils.

From these analyses several interesting conclusions are to be drawn. The dune plants have obtained and concentrated in their tissues, the same mineral constituents commonly found in plants growing on good soils, and these have been accumulated in approximately the same relative proportions. It is natural to suppose that the concentrations of the various substances in the soil would have some influence on the composition of the ash. If a soil contain a relatively large amount of potassium or phosphorus, or calcium or silicon, one might expect that these elements would be contained in the plant ash in relatively large proportion. While this influence of total quantity present in the soil is of some effect, it is not determinative. The plant takes what it needs. Contrast *Prunus* with *Artemisia, Quercus* or the three grasses or the scouring rush and note the astonishingly low silica content of *Prunus* ash compared to any of the others and the relatively high calcium. It is astonishing indeed to find a negligible quantity of silica and an extremely large proportion of calcium in the ash of a plant grown on such a highly silicious soil.

Consider those elements derived from the soil which are assumed to function in the essential metabolism of the plant, iron, manganese, calcium, magnesium, potassium, phosphorus, sulphur. From most inadequate and insufficient sources the dune plants have obtained their requirements of these necessary elements. On such a soil as beach sand, the ordinary plants of agriculture would wilt and starve. It would probably not be possible to successfully grow any sort of plant which in addition to maintaining itself normally, stores up abundantly large quantities of organic compounds suitable for human food in roots, leaves, fruits or grains. Plants of this sort would probably not reach maturity or grow at all. Certainly they would not develop into a food-producing crop, but the characteristic dune plants are at least sufficient unto themselves, carry through their life cycle successfully and win from a most refractory soil their necessary mineral sustenance. Prunus refuses silicon and gathers in large supplies of calcium whereas the grasses and the scouring rush store up large quantities of the former and are satisfied with one fourth to one third as much calcium as Prunus requires.

Those other elements, aluminium, silicon, sodium and chlorine, consistently present in plants, but apparently not essential to growth (as determined by pot and water cultures) are yet present in the ash of dune plants, although, with the exception of silica, in small proportion. Must we conclude that these elements although not essential to growth, are nevertheless not harmful, and that they are absorbed by a selective apparatus which while highly efficient is not absolute in its action, since the physiological requirements of the plant are satisfied short of positive rejection of harmless non-essentials? Or, on the other hand, are some or all of these elements, while not necessary for the normal metabolism of the plant, at least desirable in some unknown way in connection with osmotic pressures?

The older chemists puzzled much over the meaning of plant ash composition and not without reason. However regrettable the fact is, we are forced to admit that to-day we know little more in regard to the fundamental requirements of plants as regards mineral substances and the ability to obtain them from various soils and under various conditions than they did. In Liebig[7] are some hundreds of analyses in the old chemical notation unclassified save as to species and with the components in every conceivable proportion. The names of the analysts are appended but this throws little light on the subject as some of them are known to fame, others all but lost in oblivion, and as the methods of analysis used by the various investigators are not given, the degree of accuracy attained in the various cases remains unknown. Undoubtedly the

[7] "Die Chemie in ihrer Anwendung auf Agricultur und Physiologie."

methods used were less perfect than those in use to-day but even assuming that the analyses are reasonably accurate, the varying proportions and the various ingredients in the case of different species and different analyses are such that it is impossible to discern any rule or law governing their absorption by the plant. It is evident that certain mineral constituents are necessary for the plant's growth, but the minimum amount required of individual elements or the relative amounts of various elements apparently depend on a number of variables, such as species and race of plant, the soil, the season, the rainfall, the state of cultivation, etc., to such an extent that it is doubtful whether or not any sort of rule governing these proportions can ever be formulated. About all we can say is that certain elements are necessary for the normal growth of the plant and either the plant obtains these at the proper time or it suffers injury or death.

Small wonder that the older chemists failed to find the rule and all credit to them that they did ascertain the main fact.

Considering plants of all sorts, and all parts of plants, silicon is the greatest variable of all. It is invariably present but only in small amount, even to a fraction of one per cent. in fruits and edible grass seeds (grain), whereas in the stalks of the same plants it may constitute as much as seventy-five per cent. of the ash. In the light of these facts, it has been looked upon by some authors as a material of construction (the first and most natural thought) rather than as a physiologically functioning substance. This view receives some confirmation from those obvious cases in which silica serves as a structural support, as in the scouring rush and diatoms. There can be no doubt that plants acquired the silica habit early in their evolutionary history and it yet may be found to function physiologically, osmotically or structurally. It is difficult to think of an active, surviving, plant organism absorbing and storing up such a substance or any substance which has and can have no real and positive use in its life cycle. Unless silicon functions in some way in plant metabolism or serves as a building material, it is most difficult to explain the high relative portion of this element in the grasses and scouring rush, the moderate amounts in Artemesia and the almost negligible quantity present in Prunus.

It is interesting to visualize the activities of the growing root tip as it projects itself among the sand grains, moving under the reactions of the various tropisms in such wise that the weal of the growing plant is conserved; turning as necessity arises first in one direction, then in the other, but on the whole maintaining its direction, since there are no serious obstructions in the dune soil; wedging its way molelike underground, expanding, holding fast; neglecting grains of silica, lying close to potash silicates, absorbing chance molecules of calcium bicarbonate and phosphates, furnishing the chemical means if need be, of bringing the insoluble substance it requires into solution; keeping the cell pumps going to furnish the water supply to the plant in time of rain or drought; a very center of ceaseless, slow, sure activity, in which all the forces of nature seem to be at work to maintain a useless bitter plant.

W. D. RICHARDSON

CHICAGO, ILL.

THE UTAH ACADEMY OF SCIENCES

THE thirteenth annual convention of the Utah Academy of Sciences was held in the physics lecture room of the University of Utah at Salt Lake City on April 2 and 3, 1920.

At the business meeting at the close of the session, April 3, the following members were elected to fellowship in the Academy: O. W. Israelson, Utah Agricultural College, Logan; T. B. Brighton, University of Utah, Salt Lake City, and R. A. Hart, Springville.

The following were elected to membership: Dr. E. L. Quinn, University of Utah; Dr. E. E. Erricksen, University of Utah; Orin A. Ogilvie, University of Utah; Wm. Z. Terry, Ogden; Geo. P. Unseld, Salt Lake City, and Albert S. Hutchins, Springville.

The constitution was amended raising the annual dues to two dollars, effective for the present year.

A resolution, urging the United States Senate and House Committees on Civil Service, to an early adoption of the report of the Congressional Commission on the reclassification of government employees was unanimously adopted.

The following officers were elected for the ensuing year:

President, Carl F. Korstian, U. S. Forestry Service, Ogden.

First Vice-president, Dr. Frank L. West, Utah Agricultural College, Logan.

Second Vice-president, Hyrum Schneider, University of Utah, Salt Lake City.

Councillors, Dr. M. C. Merrill, Utah Agricultural College, Logan; Carl F. Eyring, Brigham Young University, Provo, and H. R. Hagan, Salt Lake City.

At the Friday evening session, the program consisted of a symposium on the subject of "The constitution of matter" and consisted of the following papers:

The theory of the constitution of matter: Dr. Orin Tugman, University of Utah, president of the academy.

The oil drop method of measuring the electric charge: Carl F. Eyring, Brigham Young University.

The electron theory of the conduction of electricity: Dr. Frank L. West, Utah Agricultural College.

The theory of valencies: Dr. W. D. Bonner, University of Utah.

The relativity theory: E. W. Pehrson, University of Utah.

The Einstein theory: Geo. P. Unseld, West High School, Salt Lake City.

Matter from the point of view of a personalistic philosophy: W. H. Chamberlain, University of Utah.

The program for the Saturday morning session was as follows:

Capacities of soils for irrigation water: O. W. Israelson, Utah Agricultural College.

The breeding of canning tomatoes: Dr. M. C. Merrill and Tracy Abell, Utah Agricultural College.

The value of farm manure for Utah soils: Dr. F. S. Harris, Utah Agricultural College.

Research work of the experiment station of the Bureau of Mines: Thomas Varley, U. S. Bureau of Mines, University of Utah.

Hydrometallurgy as applied to the mineral industry: Clarence A. Wright, U. S. Bureau of Mines, University of Utah.

Oil shales and their economic importance: Martin J. Gavin, U. S. Bureau of Mines, University of Utah.

Pyrometallurgy and its future possibilities: John C. Morgan, U. S. Bureau of Mines, University of Utah.

Chemistry and its relation to metallurgy: Edward P. Barrett, U. S. Bureau of Mines, University of Utah.

Complementary luncheon to the members of the academy by the University of Utah at the dining hall. At the luncheon, an address was given by President John A. Widtsoe, University of Utah.

At the afternoon session the following papers were read:

A capillary transmission constant and methods of measuring it: Willard Gardner, Utah Agricultural College.

Mid-tertiary deformation of western North America: Hyrum Schneider, University of Utah.

Electrical conductivity of thin metal films: Dr. Orin Tugman, University of Utah.

Is disinfection a reaction of the first order? Dr. L. F. Shackell, University of Utah.

Some problems in daylight illumination: C. Arthur Smith, East High School, Salt Lake City.

Equilibrium conditions in the system calcium sulphate-manganous sulphate-water: A. G. Kline and Dr. T. B. Brighton, University of Utah.

Standardization from constant boiling hydrochloric acid: J. T. Bonner and Dr. T. B. Brighton, University of Utah.

Comparison of the action of potassium cyanide and sodium cyanide on alkyl halides: W. D. Kline and Dr. W. D. Bonner.

The determination of arsenic as lead arsenate: A. E. Anderson and Dr. T. B. Brighton, University of Utah.

C. Arthur Smith,
Corresponding Secretary

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